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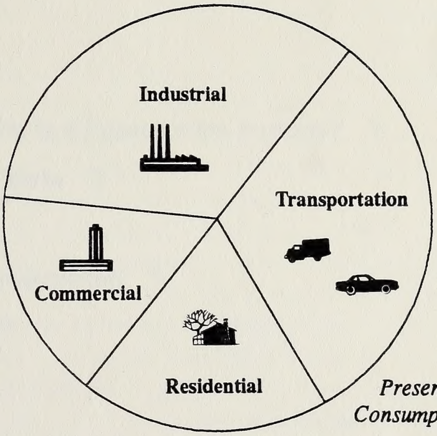
ENERGY CONSERVATION

A Goal for Albertans?



Present Energy Consumption

A discussion paper prepared for the Alberta Conservation Strategy Project

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ENERGY CONSERVATION
A Goal for Albertans?

Prepared by
Lynn Zwicky
Information Officer
Energy Conservation Branch
Alberta Department of Energy

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FOREWORD

In late 1985, the Public Advisory Committees to the Environment Council of Alberta began working toward a draft conservation strategy for Alberta. The Public Advisory Committees (PACs), comprising representatives of some 120 non-government organizations, are in many ways an ideal organization for developing a strategy that should touch the lives of all Albertans. The PACs bring together many diverse viewpoints, we are non-partisan, and we have members from across the province. Since the early days of the project, we have welcomed non-PAC participants, and have been delighted to receive the contributions of civil servants, industry spokespeople, academics, and the general public.

We have made progress since 1985: the *Prospectus for an Alberta Conservation Strategy* has been published and many meetings and workshops have been held. The principle of a conservation strategy increasingly has been endorsed by Albertans, and Alberta has been recognized across Canada as a leader in conservation strategy development. There have been important related events. For example, in September of 1987, every environment minister in Canada endorsed the final report of the National Task Force on Environment and Economy, which recommended that conservation strategies be in place in every province and territory by 1992. This same report was endorsed by the First Ministers at their November, 1987 meeting.

We will have a conservation strategy for Alberta, we hope by 1990, the Canadian Year of the Environment. Our work continues in the expectation that all those who are interested will have a chance to contribute to the project, through public hearings or some other public participation process.

Since the publication of the *Prospectus*, the PACs have concentrated on preparing sectoral discussion papers. The Conservation Strategy Steering Committee determined early on to produce background papers on relevant sectors, such as agriculture, fish and wildlife, tourism, oil and gas, and others. These discussion papers look at the issues within each sector, but, more importantly, they investigate the interaction of each sector with the others. Their preparation has involved consulting with a wide range of interest groups — a conservation strategy principle in action — which has proven fruitful in developing ideas about the ultimate conservation strategy. These discussion papers will be used as background information for drafting a conservation strategy document and, perhaps, in the future, in public hearings on the draft conservation strategy. This report is one in the series of discussion papers.

Because there are as many opinions on our best future direction as there are Albertans, we welcome comments. The conservation strategy will be only as good as the work that goes into preparing it. Please address any comments on this discussion paper or others in the series to the Environment Council of Alberta at the address given on the page opposite. I would also encourage you to make your opinions known at public hearings or other events as they are held. Let's treat Alberta as if we plan to stay!

Joan Snyder

Joan Snyder
Chairperson
Conservation Strategy Steering Committee
Public Advisory Committees to the Environment Council of Alberta

About This Discussion Paper

This is one of several papers on Alberta's energy sector that have been prepared for the Alberta Conservation Strategy project. Other papers focus on specific types of energy development and use, such as coal, oil and gas, and renewable energy. This paper looks at energy use in general in the province.

The purpose of the paper is to stimulate thinking about the costs and benefits of using energy more efficiently. It is not exhaustive and is not intended to be a thorough reference on the subject.

Acknowledgements

This paper was prepared with the assistance of numerous people. Special thanks to the Alberta Department of Energy, Energy Conservation Branch: Ian Burn, branch director; Ken Charters, industrial section director; Don Wharton, public information section director; and to staff members Doug MacLean, Nori Nishimura, Les Sladen, and Dave Whitfield, all of the industrial section. The assistance of Eugene Balogh of the department's drafting and creative services section is appreciated. Special thanks are also due to ERCB economics staff Dr. Abbas Naini, Adrienne Kwaczek, and Janice Worsick, and to John Lilley, senior research officer, Environment Council of Alberta.

Lynn Zwicky
Information Officer
Alberta Energy Conservation Branch

What Is The Role of Energy Conservation in a Conservation Strategy?

This paper shows that Albertans could reduce environmental stress and save over $700 million a year by conserving energy where it is economically justifiable. It suggests that a plan to conserve energy is needed and should be part of an overall Alberta Conservation Strategy.

Economically and environmentally sustainable development is the goal of the Alberta Conservation Strategy and conservation strategies around the world. Development and environmental preservation must go hand in hand. If we overexploit our environment for economic gain, our economies and environment will fail together. If we use the environment within its ability to recover, we can sustain both indefinitely. Energy conservation fits well with this goal, since it means using energy less wastefully. Less energy waste means fewer demands on the environment in terms of unwanted byproducts such as acid-forming emissions and "greenhouse gases" such as carbon dioxide.

The *Prospectus for an Alberta Conservation Strategy* sets out as a specific objective: "to use and manage our non-renewable resources in the interests of developing a long-term sustainable economy." Energy conservation meets this objective in several ways:

- Oil and gas will sustain Alberta's prosperity longer if we do not waste them.
- Reducing our demand for energy will make our economy more stable in the long run. We will be less affected by fluctuations in conventional energy supplies and prices. We will also keep more options open about ways to meet our future energy needs. A recent study shows that a majority of Albertans support a renewable energy future, but this will not even be a possibility if we build energy waste into our economy.[1]
- Energy conservation can diversify and expand our local economy. If we spend less money on energy, we have more money to invest in Alberta business and industry. Each individual energy user in Alberta will have more money to spend in new ways. Energy conservation also frees capital. A recent study estimates that the United States could avoid building 20 1,000-megawatt power plants by using existing technology to improve fluorescent lights. The cost of an additional 30 power plants could be saved by meeting new appliance standards for refrigerators and freezers.[2]
- Conserving energy is a less risky investment than some forms of new energy supplies. There is rarely a need for long lead times to plan and implement conservation initiatives, which, combined with quick payouts, makes them attractive to enlightened energy users. Conservation is often viewed as a cost-effective equivalent to new energy production.

Energy conservation can contribute to the goal of sustainable development in our province. This paper examines how much energy we could save, ways to encourage energy conservation, and the possible impacts of energy conservation on our economy and environment.

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[1] Edgar Jackson, "Public Preferences for Energy Resource Options: The Long Run Versus The Short Run." Forthcoming in *The Canadian Geographer*, Vol. 32, 1988.

[2] Arthur Rosenfeld and David Hafemeister, "Energy-Efficient Buildings." *Scientific American* 258(4):82-84. April 1988.

The Potential To Conserve Energy in Alberta

What Is Energy Conservation?

If we chose to give up our cars, freeze in the dark, and buy only the necessities of life, we could save a lot of energy. Such draconian measures obviously aren't reasonable, but where should we draw the line? This paper assumes that:

- Energy conservation means using less energy to produce the same goods and services we enjoy now.
- Measures to conserve energy pay for themselves in a reasonable period of time — about five years at most. Many measures have paybacks of less than a year.

In other words, we are looking at ways to save energy that are economic and that do not require a change in our comfort or standard of living. These are conservative assumptions. Albertans may be willing to pay a higher price for environmental conservation.

How Do We Use Energy Now?

Before we can estimate the potential to save energy in Alberta, we need to take inventory of how energy is used. The Energy Resources Conservation Board (ERCB), the agency that forecasts energy demand and regulates energy development in the province, sets out four energy use sectors: residential, commercial, industrial, and transportation. Table 1 describes the major energy users and uses in these categories. Figure 1 shows the contribution of each energy use sector to total energy demand.

What Technologies Are Available to Save Energy?

There are many ways to economically save energy. The following discussion is not exhaustive; rather, it uses examples from each energy use sector to illustrate techniques available.

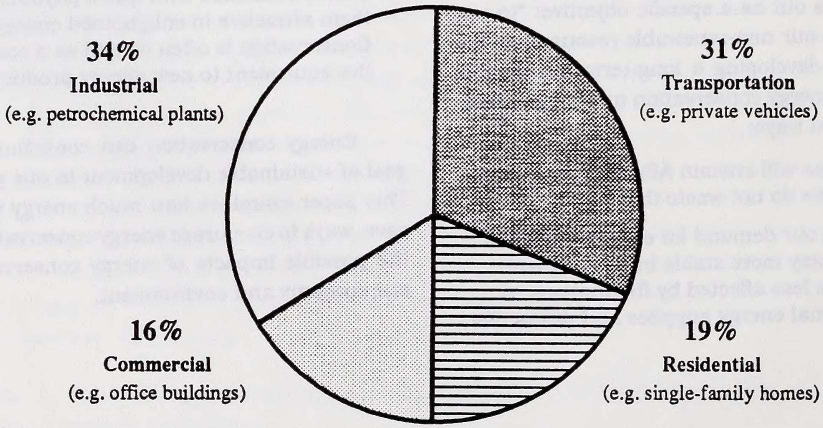

Figure 1. Percentage of Total Energy Use by Energy Use Sector in Alberta (ERCB 1986)

Residential Sector

Energy use in the residential sector is fairly uniform and we know that the same energy-saving techniques will apply in most situations. The exception is apartment buildings, which make up about 10 percent of the housing stock; they have unique ventilation, air conditioning, and lighting demands. For the rest of the residential sector, energy-saving measures include:

- Insulating and tightening the building shell. This reduces space heating costs by reducing heat transfer. Note that airtight houses require controlled ventilation to maintain good indoor air quality. Pollutant-free construction materials will also improve indoor air quality.
- Higher efficiency heating systems. These reduce the amount of energy needed to provide useful heat to a home.
- Higher efficiency appliances. These reduce electricity and gas requirements.

On average, the standard home we are now building in Alberta is about 50 percent more efficient in space heating requirements than homes built before 1981. We have the skills to build houses that are 80 percent more efficient than those built before 1981, but the economics of doing so are not as good. We can also improve the energy efficiency of existing homes. A study of air tightness improvements on a cross section of Calgary homes showed that sealing joints and cracks with weatherstripping and caulking would save

Table 1. Energy Users and Energy Use

Energy Use Sector	Major Energy Users	Major Energy Uses
Residential	single family homes apartments (including high rises) row housing mobile homes duplexes	natural gas (space and water heating) electricity (appliances, lighting, ventilation, air conditioning)
Commercial	office buildings (private and government) hospitals educational institutions recreation facilities restaurants other retail space	natural gas (space and water heating, ventilation) electricity (lighting, ventilation, air conditioning, refrigeration)
Industrial	petrochemical plants oil refineries oil sands plants gas plants forest products cement plants other industry	natural gas and electricity for process use
Transportation	commercial fleets private vehicles agricultural vehicles other transportation (air, rail)	refined petroleum products

about 14 percent on energy required for space heating and pay back the cost of materials in about 2.6 years.[3] Insulating an uninsulated basement will typically save almost a quarter of the energy used for space heating and pay back the cost of materials in under five years.

Household appliances can also be much more efficient than they are now, and not necessarily more expensive. Standards proposed in Ontario (Bill 82) and nationally could reduce the electricity used by refrigerators alone by almost 40 percent. An internal report by Energy, Mines, and Resources Canada estimates that Canada could economically avoid 500 megawatts of new electrical generating capacity by 1995 if the American appliance standards for 1990 were adopted.

Commercial Sector

Energy use in the commercial sector is not uniform and neither are the technologies for saving energy. Restaurants and schools, for example, use energy in very different ways. Office buildings are the largest single type of energy user in the commercial sector, and our example of energy-saving technology is drawn from there.

In 1984, the Energy Bus of the Energy Conservation Branch, Alberta Department of Energy, did an energy audit of a medium-sized commercial office building in Edmonton. The Energy Bus personnel recommended a number of measures to economically reduce energy use in the building. The following measures were implemented:

- Lights in the building were changed from 40-watt fluorescent tubes to 35-watt fluorescent tubes.
- A small air conditioning system was installed for the building's board room. Before this was installed, the system for the whole building had to be turned on to cool the board room, which was used about once a month.
- The temperature of the under-building parking garage was allowed to drop to 10°C (50°F).

Since 1984, these simple measures have reduced the building's energy requirements by about 23 percent. Their total cost (reducing the temperature of the garage didn't cost anything) was about $24,500 and the payback period for all of the energy-saving measures combined was a little over a year. A follow-up audit completed in 1987 identified further potential energy savings of 16 percent.

Industrial Sector

Energy use in the industrial sector is highly varied. Processes differ from plant to plant depending on what is being produced and how. Because industry uses a lot of process heat, waste heat recovery technology can be an important way to save energy. An example is a demonstration project at Lakeside Packers in Brooks, where heat recovered from a refrigeration unit is being used to produce some of the hot water the plant needs. Based on 1987 prices, the project has saved about $35,000 a year in energy costs, for an investment of about $100,000. The payback period is a little under three years. The plant has recently started buying cheaper gas in bulk from local suppliers and the lower prices will extend the payback period.

Cogeneration is another type of energy conservation technology. It uses a single source of energy to produce both heat and electricity. The thermal efficiency of thermal electric generation plants is about 35 percent. That means 65 percent of the heat generated to produce electricity is lost. Cogeneration plants operate at a much higher thermal efficiency. Industries that use cogeneration are able to lower their peak demand for electricity from the grid (which reduces their electric utility costs) and displace the energy needed for process or other heat. According to a 1987 study by the Canadian Energy Research Institute, Alberta leads Canada in installed cogeneration capacity and has a high potential for more cogeneration in its petrochemical industries.[4]

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[3] Bill Johnson Architect Ltd., "A Survey of Air Leakage in Calgary Homes." Alberta/Canada Energy Resources Research Fund, April 1986, p. 6.

Recovering waste heat is not the only way to conserve energy in the industrial sector. For example, Syncrude Canada's oil sands plant at Fort McMurray has reduced the amount of energy it uses to produce a barrel of oil by 30 percent in the last six years.

Some of the measures that achieved this saving are:

- Solving design problems and following a routine of preventive maintenance.
- Reducing steam requirements in the extraction hot water separation process.
- Monitoring and adjusting equipment such as boilers, furnaces, heat exchangers, and steam traps.

The economics of these measures were excellent, since they required very little capital to implement.

Transportation Sector

Vehicles are available on the market today that are as much as 50 percent more efficient than the average car. But new equipment is not the only way to achieve energy savings in the transportation sector. We can use the vehicles we have more efficiently. These are examples of measures that would save fuel for both private car owners and commercial fleets:

- Shifting gears at lower RPMs
- Gradual acceleration and deceleration
- Minimizing idling
- Highway speeds of 90 kilometers per hour
- Route planning to avoid heavy traffic and unnecessary distance
- Maintaining proper tire inflation and engine repair

H and R Transport in Lethbridge, a trucking company with about 70 vehicles, has practiced fuel-saving measures since 1986. The company gives its drivers a three-cents-per-mile bonus for driving at 90 kilometers per hour, which it monitors with a tachograph installed on the trucks. This alone has accounted for a 12 percent reduction in fuel use. More savings are expected from the new trucks the company has recently bought. Special aerodynamic design and engine modifications make the new trucks about 40 percent more fuel efficient than the existing fleet.

How Much Energy Could We Save?

This section estimates the amount of energy Alberta could save through economically justifiable conservation. The energy savings presented are based on conservation technologies available today and 1986 energy use data.

The estimate is conservative because:

- No agricultural vehicles are included. There is not enough information about their conservation potential.
- Only major fuels are included (natural gas, propane, diesel, motor gasoline, and electricity generated by utility companies). Aviation fuels, kerosene, light and heavy fuel oil, synthetic crude oil, coal, and wood are left out. These make up about eight percent of total energy demand.
- Conservation potential is measured against the average price (per unit of energy produced) that utility companies charge their customers. The marginal cost* of new energy development is usually higher than this average price. If we used the marginal cost to assess conservation potential — which would be reasonable since conservation can reduce the need for new energy development — more energy conservation would be economically justifiable. The

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[4] Anthony Reinsch and Ellen Battle, *Industrial Cogeneration in Canada: Prospects and Perspectives.* Calgary: Canadian Energy Research Institute, March 1987, p. 85.

* Marginal cost is the extra cost incurred for an extra unit of output.

analysis assumes averaged 1987 or current 1988 prices. If energy prices go up, which Albertans can expect in the long run, the potential for economically justifiable conservation will increase.

- The dollar savings do not include reductions in demand charges. Demand charges are what industries pay based on their peak electrical use.
- The conservation potential of energy used for pipeline and utility networks is not included.

Even under these conservative assumptions, the financial savings to Alberta's economy from energy conservation are impressive. These savings will continue from year to year once we begin conserving energy. The sooner we begin, the greater the total benefits.

Residential Sector

There is very little hard data available on the conservation potential of Alberta homes. We do not know, for example, what percentage of homes have insulated basements or the average age of major household appliances. We have relied on ERCB estimates[5] for a figure on the conservation potential in Alberta's residential sector. Savings in natural gas use depend on the potential to improve space heating efficiencies. About 74 percent of Alberta's residential stock was built before 1981. For its 1986 forecast, the ERCB estimated that improvements to these residences could reduce their energy use for space heating by 15 percent. The residences now being built are about 50 percent more efficient than the pre-1981 stock, and we assume that no further improvements to these homes would be economically justified. This means that the overall potential for space heating energy reductions in the residential sector is about 11 percent.

Since the assumption that new residential stock cannot be improved economically may be incorrect, 11 percent is a conservative estimate of conservation potential.

The bulk of electricity in homes is used by major appliances: refrigerators, freezers, furnace fans, ranges, laundry equipment, dishwashers, and hot water heaters. For conservation of electricity, the ERCB used estimates of the number of appliances per home and data from the American Electric Power Research Institute on efficiency improvements in appliances. According to this information, Alberta homes could use as much as 16 percent less electricity. This figure only assumes technologies that consumers can buy now. If it takes 10 years for most major appliances to be replaced, technologies with even higher efficiencies will probably be available.

Commercial Sector

The data from Alberta's Energy Bus audits are among the most comprehensive in Canada. Based on Energy Bus audits of 898 commercial facilities — including office buildings, recreational facilities, educational institutions, and hospitals, among others — overall energy savings of between 18 percent and 29 percent are possible. The average energy savings in natural gas were 24 percent. For electricity, average energy savings were 13 percent.

Industrial Sector

The best information on conservation potential in Alberta's industrial sector is again from Energy Bus audits. Audits of 136 facilities — including petroleum and natural gas plants, meat and poultry producers, concrete product manufacturers, and wood products manufacturers, among others — show overall energy savings could be about 20 percent. Potential energy savings in natural gas use were 22 percent on average; average possible reduction in electricity use was nine percent.

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[5] ERCB, *Energy Requirements in Alberta 1986 — 2010*. October 1986.

Transportation Sector

Estimates of conservation potential in Alberta's transportation sector are primarily based on studies from other provinces and the United States. The success commercial fleets in Alberta have had with fuel-conserving measures, and the experience of the Energy Conservation Branch with driver training, confirm that these studies apply here. The impact of driver training, proper vehicle maintenance, route planning, and new fuel-efficient vehicles on energy use in the transportation sector can be very high. Using these four techniques, some commercial fleets in Alberta have obtained fuel savings of 40 to 50 percent. Twenty percent, the figure we assume, is a very conservative estimate of the overall conservation potential in the transportation sector.

Overall Conservation Potential

Figure 2 summarizes the amount of energy we could save in Alberta each year, by sector, assuming the conservation potentials estimated above.

Remember that these are conservative estimates. If you add up the energy savings across all sectors by fuel type, this is what you get:

- We could save more natural gas than is required to heat all the single-family homes in Alberta for a year.
- We could save almost as much electricity as one of the new generating units at Genesee will produce in a year.
- We could save more diesel and gasoline than all the cars in Edmonton would use in a year (see Figure 3).

In dollar savings, this level of energy conservation is worth over $700 million. By comparison, this is more than two-thirds of the revised projected provincial deficit for 1987/88. See Appendix 1 for details on the calculation of energy and dollar savings.

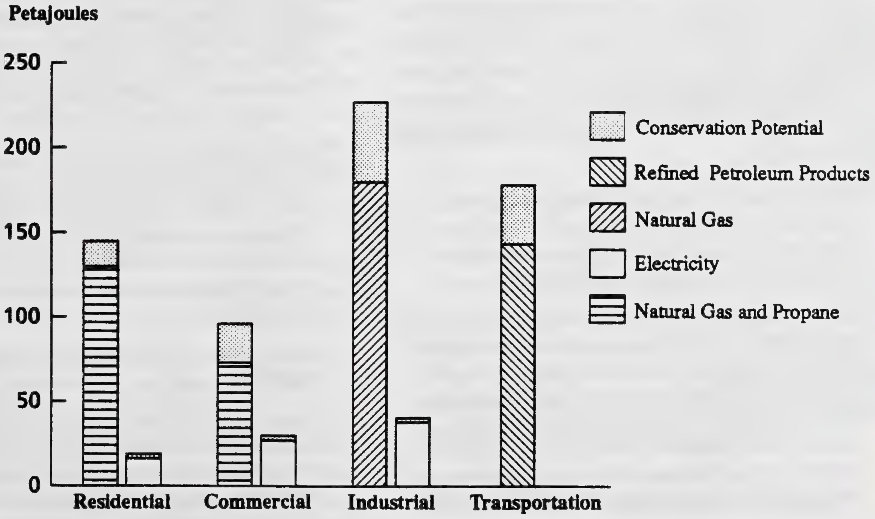

Figure 2. Annual Energy Use and Conservation Potential by Sector

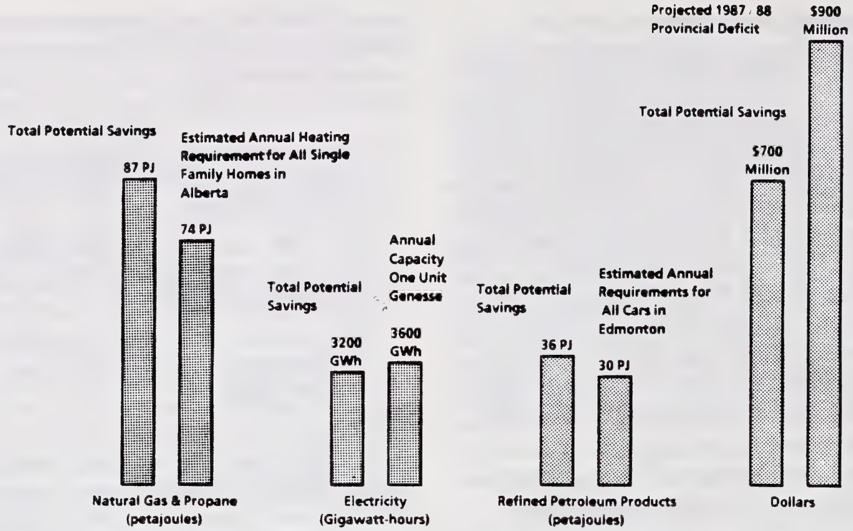

Figure 3. Annual Conservation Potential Comparison

Barriers to Energy Conservation

Though the amount of energy conservation described in the last section is economically justifiable, it is not now fully exploited. We know, for example, that less than half of the savings identified by Energy Bus audits have actually been implemented. Barriers such as the following stand in the way:

- Lack of awareness that saving energy can save money. Since energy in Alberta is abundant and cheap, the fact that we can save it economically is easily overlooked.
- Lack of funds to finance energy conservation measures. A questionnaire to Energy Bus audit clients showed that this was a key barrier. When capital is scarce, businesses tend to concentrate on product-related investments with payback periods as short as two years. Energy conservation investments are not a priority under these circumstances.
- A utility pricing structure that discourages efficient energy use. Utility companies in Alberta charge less per unit of energy the more energy you use. This "declining block rate" pricing, common in North America, encourages use of the energy supply system to its full capacity. This pricing structure is an advantage to utility companies because they do not earn money on capacity that sits idle.
- Low Alberta energy prices. Because energy in Alberta is cheap, a consumer must save a lot of energy to generate a lot of cash flow. This can make energy conservation, though economic in terms of payback, less attractive to business and industry than other investments.
- Lack of energy performance standards for buildings, appliances, and vehicles.
- Lack of awareness of the impacts of energy development and use on the environment. Environmental protection is becoming more and more of a priority with people across Canada. If Albertans were more aware of how saving energy could protect the environment, energy conservation might become more of a priority.

Some Actions to Encourage Energy Conservation

Programs in Alberta

In Alberta, most programs to encourage broader implementation of energy conservation have been developed by government. (Of course, energy users of all sorts have individually taken steps to save energy.) Some programs are designed exclusively for saving energy, while others touch on energy conservation as part of general programs that provide information or funds for building improvements, housing research, or driver training.

Alberta's information and education programs tackle one of the critical barriers to energy conservation: lack of awareness of the opportunities to conserve energy and the resulting benefits.

Programs that primarily focus on energy conservation include the energy monitoring program for senior citizens' apartment buildings through the Alberta Mortgage and Housing Corporation; the energy monitoring program and construction guidelines for provincial government buildings through Public Works, Supply and Services; and, until recently, the Research, Development and Demonstration funds for conservation and renewable energy projects in housing, industry, and business through the Alberta/Canada Energy Resources Research Fund (A/CERRF). The work of the Energy Conservation Branch (ECB) of the Alberta Department of Energy is exclusively devoted to programs that encourage energy conservation.

The ECB is an education and information agency that works to enlighten a variety of groups about how to reduce energy costs through conservation. These groups include:

Business, Industry, and Institutions

On request, the ECB will audit the energy use of businesses, industries, and institutions to identify potential savings. Accumulated results of Energy Bus audits are available to consultants and others by means of a comprehensive database. The ECB also has a series of publications on energy management for this sector.

Motorists and Fleet Operators

The ECB distributes the Fuel Economy Calculator, which helps motorists determine the fuel efficiency of their vehicles, via service stations across the province. Printed materials on fuel efficiency are available to driver training schools, motorists, and fleet operators. Commercial Driver Energy Conservation Awareness Training (DECAT) is available on request and soon commercial fleets will be able to receive an energy audit via the Energy Bus program.

Homeowners and Housing Industry Professionals

The ECB publishes a series of booklets on energy conservation, distributed through building supply stores and other retail outlets, and operates an inquiry service for consumers and housing industry professionals. It also has audiovisual training materials on energy-efficient residential construction available on loan to all Albertans.

Teachers and Students

In conjunction with the planners of the Alberta science curriculum, the ECB has developed teaching kits on energy conservation for grades one to six and for high school physics and industrial arts courses, which it distributes at no charge. It also visits elementary schools across the province with informative and entertaining presentations on saving energy.

Most of these programs work on the barrier of awareness by providing education and information to energy users in all sectors and to future energy users — school children. In some provinces and the United States, programs to overcome other barriers are available, and sometimes agencies other than government are involved.

Programs in Other Jurisdictions

In Ontario and Quebec, the provincial governments help industry pay for feasibility studies on energy-conserving measures recommended in provincially sponsored audits. About one third of the industries audited in Ontario take advantage of the program. Ontario also promotes the use of new energy-conserving technologies in industry by funding demonstration projects.

The federal government, through the Department of Energy, Mines and Resources, supports national training and demonstration activities. The R2000 super-energy-efficient housing program is one example that has had an influence on housing construction in Alberta. Another demonstration program, Enerdemo, also funds a variety of energy conservation demonstration projects.

In the United States, many utilities use economic incentives to encourage energy conservation because it is cheaper and less risky than investing in new energy supplies. Pacific Gas and Electric Company, a utility company in California, has found that generating a kilowatt hour of electricity from a new power plant costs seven times more than saving a kilowatt hour through conservation programs. Through grants and loans to its customers, the utility plans to avoid $5 to $7 billion in new generating capacity over the next decade.[6]

In Ontario and Quebec, and in many parts of the United States, energy conservation project financing is also available through "energy service companies." These companies put up the capital for a project in return for a share of the savings that it generates. In Ontario and Quebec, the provincial government helped finance these companies, either as a joint venture or through a loan.

The Impacts of Conserving Energy

We already know that pursuing energy conservation in Alberta requires commitment from industry, government, and the general public. What effect would it have on other aspects of our lives?

Energy conservation would have impacts on the environment, the oil and gas industry, utility companies, and Alberta's energy users.

Environment

The major environmental impacts of supply development are addressed by the requirements imposed by the Energy Resources Conservation Board (ERCB) and the Department of the Environment. These requirements, continually being reviewed and updated, help ensure that appropriate technology is used to minimize environmental disruptions.

Over 75 percent of the oil and gas produced in Alberta is exported; however, with the remainder, significant environmental gains are possible that relate to improved end-use energy efficiency.

Almost all of the electricity we generate in the province is for our own use. Conserving electricity will reduce the need for:

Coal Mines Over 80 percent of our electricity is thermally generated from coal. We mine the coal in strip mines, which disrupt the land and water ecosystems in their vicinity. We do reclaim strip mines, but more efficient use of electricity would reduce the number of mines we need in the first place.

Emissions Alberta is fortunate to have low-sulphur coal, which helps to reduce undesirable emissions from coal-fired power plants.

Dams We now generate about four percent of our electricity from hydro. The dams we build for this purpose have big impacts on rivers. The reservoirs flood habitat upstream and change temperature and flow regimes downstream, altering ecosystems.

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[6] Arthur Rosenfeld and David Hafemeister, "Energy Efficient Buildings." *Scientific American* 258(4):80. April 1988.

Transmission Lines Transmission lines cut corridors through wildlife habitat and remove agricultural land from production. Thousands of acres have already been disturbed by transmission lines.

Any use of fossil fuels — in cars, heating systems, or industry — contributes to air quality problems. When burned, fossil fuels typically release sulphur dioxide and nitrous oxide, two of the compounds that contribute to acid rain. In Alberta, sulphur dioxide is mostly emitted by extraction gas plants, oil sands plants, and power plants. Nitrous oxides mostly come from the refined petroleum products we burn in our cars, which are by far the major source of air pollution in Alberta's cities. All fossil fuels release carbon dioxide when they burn.

Climatologists predict that the accumulation of carbon dioxide in the atmosphere will lead to the "greenhouse effect," a global warming trend that will severely alter ecosystems around the world. Continued review of appropriate standards for allowed emissions (with upgrading where necessary) and increased efficiency in the use of energy will place fewer stresses on the environment.

Oil and Gas Industry

Alberta's oil and gas industry is now the cornerstone of our economy. Since we only use about 23 percent of what we produce in the province, domestic conservation would have little impact on the profits of the industry. The energy industry has implemented energy conservation measures in refineries and other operations as a means to remain competitive in the face of uncertain oil prices.

Utility Companies

Less energy use would mean less revenue for utility companies. The profits of utility companies are regulated in Alberta; the companies do not make money until the facilities they finance are required to meet energy demand. If demand drops due to energy conservation, fewer facilities are required and utility company profits decline, although their percentage return on investment remains constant.

At the same time, developing new energy facilities poses a financial risk for utility companies. They cannot recoup their investment in new facilities until the facilities are actually needed to meet demand. In recent years, demand has been overestimated, especially for electricity. Since electrical utilities must plan new generating capacity years in advance, they have been left with large unrecovered investments in partially finished plants. Implementing energy conservation takes less planning time, less capital, and would delay the need to build new generating capacity, and the associated financial risks.

Alberta's Energy Users

Energy conserved is money in the pocket for all energy users — homeowners, institutions, businesses, and industries. The money saved on energy would amount to more disposable income for consumers to spend on local business, more money for hospitals and schools to finance programs, and more capital for local business and industry to invest in products and services. Local businesses involved in the manufacture, delivery, or installation of energy-conserving products — such as industrial control manufacturers, heating system suppliers, and home renovators — would benefit directly. Energy conservation could help create a more vital local economy. It would also help cushion Alberta energy users from the impact of future energy price increases.

Where Do We Go from Here?

Our present pace of energy use will not lead to environmental crisis immediately, but we can expect to run into more and more difficulty as time goes on. Our population will grow, our energy demands will increase, and we will be forced to find new energy sources. Waste will create needless pressure to develop agricultural land, wildlife habitat, and recreation areas for resource mining and transmission. It will needlessly increase pollution levels from the use of fossil fuels.

Energy conservation has clear-cut benefits for Alberta. It frees a substantial amount of money for our local economy. It protects energy users from energy supply and price fluctuations. It extends the life of our fossil fuel reserves and the prosperity we derive from them. It reduces environmental stress from energy development and use. It keeps more choices open in meeting our future energy needs.

If we do not take deliberate steps to encourage energy conservation, however, we will probably not achieve the full degree of conservation that is economically possible. We need to continue with information and education programs about energy conservation, and evaluate opportunities to overcome other barriers. A plan of action to encourage energy conservation should be part of the Alberta Conservation Strategy.

Appendix 1. Alberta Conservation Potential Calculations

			Savings		
Energy Use Sector	Energy Use* (1986)	Conservation Potential	in Energy (total)	in Energy ($/unit)	in Dollars (millions)
Residential					
Natural Gas	137,899 TJ	11 percent (a)	15,169 TJ	$2.44/GJ(e)	$37
Propane	8,681 TJ	11 percent (a)	955 TJ	$4.28/GJ(f)	$4
Electricity, urban	5,336 GWh	17 percent (b)	907 GWh	$0.067/kWh(g)	$61
Electricity, farm	7 GWh	17 percent (b)	56 GWh	$0.545/kWh(g)	$3
Commercial					
Natural Gas	90,134 TJ	24 percent (c)	21,632 TJ	$2.38/GJ(h)	$52
Propane	6,201 TJ	24 percent (c)	1,488 TJ	$2.21/GJ(i)	$3
Electricity	8,869 GWh	13 percent (c)	1,153 GWh	$0.046/kWh(h)	$53
Industrial					
Natural Gas	227,787 TJ	21 percent (c)	47,835 TJ	$2.28/GJ(h)	$109
Electricity	12,073 GWh	9 percent (c)	1,087 GWh	$0.046/GWh(h)	$50
Transportation					
Retail Gasoline	115,620 TJ	20 percent (d)	23,124 TJ	$10/GJ(i)	$231
Retail Diesel	16,738 TJ	20 percent (d)	3,348 TJ	$9.50/GJ(i)	$32
Commercial Gasoline	18,238 TJ	20 percent (d)	3,638 TJ	$8.46/GJ(j)	$31
Commercial Diesel	29,091 TJ	20 percent (d)	5,818 TJ	$6.44/GJ(j)	$37
Total Savings					**$703**

Fuel	Units	Dollars (millions)
Natural Gas	84,636 TJ	$193
Propane	2,443 TJ	$7
Electricity	3,203 GWh	$171
Refined Petroleum Products	35,938 TJ	$332
Total		**$703**

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* Data from ERCB, *Energy Requirements in Alberta 1986 — 2010*. October 1986

Notes:

(a) Based on ERCB estimates.

(b) Based on ERCB estimates and Electrical Power Research Institute (EPRI) estimates.

(c) Based on Alberta Energy Bus audit data.

(d) Alberta Energy Conservation Branch estimate from Canadian and American transportation studies.

(e) 1987 average residential energy rate, Northwestern Utilities and Canadian Western Natural Gas. Does not include provincial rebate.

(f) 1988 current residential rate for Edmonton, Mohawk Oil. Includes 35 percent provincial rebate.

(g) 1988 current residential energy rate, TransAlta Utilities. Does not include income tax rebate or municipal franchise tax.

(h) 1987 average price from Alberta Energy Bus audit data. Includes Alberta government rebates, municipal taxes, and Electric Energy Marketing Agency averaging.

(i) 1987 average retail price (Edmonton) from data in *Energy Pricing News*.

(j) 1987 average contract price (Edmonton) from data in *Energy Pricing News*.

Units of Measurement for Energy

Various units are used to measure energy. Some useful information about these units is given below.

The basic unit of energy in the International System of metric measurement is the joule. It is defined as *the work done when the point of application of a force of one newton is displaced a distance of one meter in the direction of the force.* As in other metric measurement systems, prefixes are used to indicate order of magnitude:

kilo-	10^3	kJ	thousands of joules
mega-	10^6	MJ	millions of joules
giga-	10^9	GJ	billions of joules
tera-	10^{12}	TJ	trillions of joules
peta-	10^{15}	PJ	quadrillions of joules

Energy can also be measured by watt hours, a metric measurement not favored by the International System, but commonly used. Large numbers of watt hours are also expressed using the prefixes given above, for example, kilowatt hours (kwh), meaning units of one thousand watt hours. Some useful conversion factors are:

1 watt second = 1 joule

1 kilowatt hour = 3.6 megajoules

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